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SOME FACTORS AFFECTING CATTLE USE OF NORTHERN ARIZONA PINE-BUNCHGRASS RANGES

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Stretching in a majestic arch across northeastern Arizona lies an almost unbroken belt of ponderosa pine timberland. Within the nearly 4 million acres of this forest empire the production of commercial saw timber and the grazing of domestic livestock take place side by side. Natural stands of ponderosa pine do not grow in continuous stands with a closed canopy, but rather in scattered groups. Underneath and between the larger trees and in the open parks or meadow areas, a mixture of palatable, nutritious bunchgrasses normally occurs. On this pine range forage are grazed tens of thousands of cattle and sheep each summer, thus forming a vital link in the chain of livestock production in the Southwest.

Taken collectively, the bunchgrass ranges of northern Arizona are characterized by extremely uneven forage utilization when grazed by cattle. Much of this is caused by the scarcity of livestock watering places, since range water is extremely difficult to develop on the porous volcanic soils characteristic of the plateau country. Several other factors also affect the natural movement and grazing tendencies of cattle on pine bunchgrass range. It is the purpose of this report to discuss the effect of water and these other factors upon the grazing use of the important forage species occurring in the pine-bunchgrass type.

The information is based upon data collected during 1940 and 1941 on three typical grazing allotments designated as A, B, and C and located on the Coconino and Kaibab National Forests near Flagstaff, Ariz.

Characteristics of the Pine-Bunchgrass Type

Forage Plants

The principal forage species listed in order of importance are: mountain muhly,[3/] Arizona fescue, pine dropseed, and bottlebrush squirreltail (fig. 1). Measurement of plant density on the three allotments studied showed that mountain muhly and Arizona fescue make up about 75 percent of the total perennial forage stand, with mountain muhly a little more than twice as abundant as the fescue.

Other grasses usually present but in smaller amounts are prairie junegrass, muttongrass, Arizona threeawn, little bluestem, and black dropseed. In the more moist, meadowlike areas, redtop, alpine timothy, and water foxtail may be found; also, in many such areas, the introduced

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2/Associate Forest Ecologist now with U. S. ARmy Air Corps. Final draft of manuscript prepared by Kenneth W. Parker. The project was planned and conducted under the general supervision of W. G. McGinnies. Statistical computations by Geraldine Peterson.

3/Scientific names of plants are listed at end of the report.

Kentucky bluegrass is apparently increasing. Weeds, particularly asters and daisies, and such legumes as lupines, clovers, and vetches, are seasonally conspicuous. On the whole, however, weeds are of minor importance because they make up only about 20 percent of the forage cover and are grazed only during short periods when most palatable, although they are helpful from the viewpoint of animal nutrition.

Palatable browse plants comprise only about 5 percent of the total plant cover, and, except in local areas, are of little importance as forage. Among those present, Gambel oak, Fendler ceanothus, mountain-mahogany, and New Mexican locust are most common.

Climate and Growth Periods

The Coconino Plateau lies largely at an elevation varying from about 6,000 to 8,000 feet, consequently temperatures are low. Frost may occur during any month of the year, but ordinarily there is a frost-free growing season of about 120 days. Average annual precipitation is 22 inches. Of this, approximately 13 inches occur during the fall, winter, and spring seasons when most forage plants are dormant. The remaining 9 inches fall mainly in the form of rain during the months of July, August, and September, and may be considered as effective in the production of range forage, although some early summer growth, particularly with Arizona fescue, is produced on the strength of moisture left in the soil from the spring thaw. The major forage production period starts about the second week of July with the beginning of the summer rains and ends about the middle of September. "Killing" frosts may be expected to occur during early October.

Soils and Topography

Over most of the Plateau in the vicinity of Flagstaff the soil is a silty loam, with varying amounts of fine sand and clay. On much of the area the principal parent soil material is volcanic ash or cinder, although sedimentary limestone outcrops are found. Subsoils are invariably porous, and in places the surface soil is sufficiently covered with malpais rocks and boulders to materially affect the free movement of cattle.

The terrain is generally smooth or undulating, although occasionally extremely steep slopes are encountered along drainage courses and on the sides of isolated high peaks. The average slope as measured on a typical grazing allotment near Flagstaff, Ariz., was 10 percent. Natural watering places are scarce. On the three allotments studied there were no permanent live streams so that livestock are dependent upon developed springs and seeps, surface tanks, and natural catchment basins or lakes.

Prevailing Type of Management

Within the national forests of the Southwest cattle are usually permitted on the pine-bunchgrass ranges for a period of about 5 months extending from June 1 to October 31, although the actual date of entry and the date of leaving vary, depending upon weather conditions and the availability of forage in other areas. Steers are ordinarily the most popular class of livestock, but cows with calves at their sides are not uncommon. That the ranges are well suited to a steer operation is

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Figure 1.-- Steers on pine bunchgrass range, near end of grazing season in November. Principal perennial grasses are mountain muhly, Arizona fescue, and pine dropseed.

evident from the fact that good quality Hereford steers commonly gain 200 pounds or more during a 5-month season on the bunchgrass range. Most of the steers grazed are sold as feeders, although during some years a few animals are marketed grass fat.

Grazing allotments within the pine-bunchgrass type are variable in size but tend to be rather large. The three allotments studied, respectively about 20, 30, and 45 sections in area, were considered typical. No cross fences existed in the allotments, so that except for natural barriers the cattle were free to move at will. Each of the three allotments was stocked at capacity as determined by range surveys and records of past utilization and stocking.

Principal Factors That Affect Forage Utilization

As a general rule cattle follow the line of least resistance in securing forage and water. Travel is usually the minimum necessary and is ordinarily done over the least arduous routes. Consequently, steep slopes, rocky terrain, dense timber reproduction, and other physical barriers exert a direct influence on cattle movement and degree of forage utilization. Other factors which influence grazing include condition of the soil and the forage cover, floristic composition of the forage stand, and growth stage of the plants. The more important of these factors are discussed under the headings "Physical Barriers" and "Factors Affecting Forage Value."

Physical Barriers

Distance to a watering place. In the pine-bunchgrass type cattle will go to water at least every second day, and during the warmest part of the summer most of them will water every day. Consequently, the utilization of forage within a range unit is closely tied in with the location of the watering place.

The relative effect of water as a factor in distributing grazing use increases directly with distance between watering places. Talbot[4/] found that about 1/2 mile was the maximum limit of cattle movement in steep, rough country, and the present observations substantiate that figure. On allotment B, where the average distance to water was 1.9 miles, the grazing use on the two major forage species decreased with increased distance from water at almost twice that on allotment A, where the average distance to water was 1.1 miles (fig. 2). On allotment C the average distance to permanent water was also 1.1 miles, but in addition to the permanent watering places, water was intermittently available throughout the grazing season at numerous small temporary watering places. The value of temporary waters is illustrated by the fact that on this allotment, as a whole, there was no significant[5/]

4/ Talbot, M. W. Range watering places in the Southwest. U. S. Dept. Agr. Bul. 1358. 43 pp., illus. 1926.

5/ The use of the word "significant" is used in a statistical sense meaning a likelihood of 19 to 1 that the difference between means is actual and not due to chance.

correlation between the measured intensity of grazing use and distance from the permanent watering places.

The trends shown in figure 2 indicate that grazing use[6/] of Arizona fescue becomes negligible at a distance of 3 to 4 miles from water and little or no use of mountain muhly will occur on areas located more than 4 to 5 miles from water. Actually, however, satisfactory use of any large area of forage that is located more than 1 to 2 miles from a watering place is impractical in the pine-bunchgrass type. Isolated small pockets of exceptionally choice forage and some immediately adjacent to important stock trails are sometimes grazed at a considerably greater distance from water.

The obvious disadvantage of too great a distance between watering places is that cattle are forced to spend a large portion of their time in trailing to and from water. Consequently, a considerable amount of energy which would otherwise go into the production of beef is expended in walking. Furthermore, forage utilization is invariably excessive near the watering places, while other large areas of good forage, located within the unit but inaccessible because of distance from water, go unutilized year after year.

The development of additional permanent range watering places in the pine-bunchgrass type to provide water at distances not more than 2 miles apart can be expected to improve the distribution of grazing use and lead to increased beef production. In addition, the development of all possible temporary watering places, coupled with the active encouragement, through judicious salting and riding, of cattle to use these temporary waters whenever available, is definitely worth while.

Steepness and length of slope. Where forage is available on level terrain, cattle ordinarily avoid uphill travel except along well-established trails with good walking surface and low gradient, the usual tendency being light use of the range plants on steep slopes and heavy use on level or nearly level areas. However, the effect of slope is a function of two measurable factors, i.e., steepness and length. For example, a narrow fringe along the bottom of slopes as steep as 80 percent will be readily used by cattle, whereas the forage on slopes of only 20 percent will be practically ungrazed if the slope is prolonged for a distance of more than 1 mile. This relationship is shown graphically in figure 3 which gives the calculated utilization that occurred on mountain muhly at varying distances from the bottom of slopes of varying steepness on allotment A.

6/ Grazing use as referred to throughout this paper is percent use in terms of weighted height removal as determined from basal intercept and herbage height of all grazed and ungrazed grass clumps on a 50-foot transect line. The ratio of percent use as determined by this method with the ocular estimate of weight removal was 1.35:1 and compared with Region 3 utilization slide rule in terms of weight removal was 1.32:1

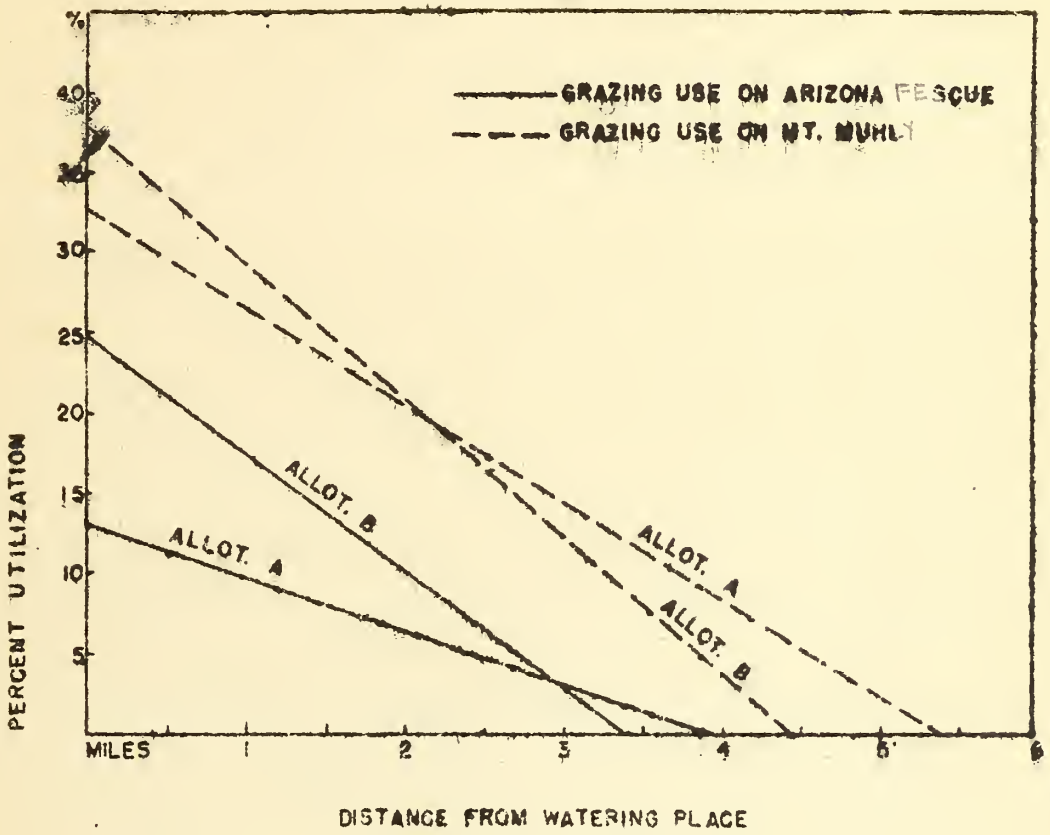

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Figure 2.- Decrease in grazing use due to distance from water.

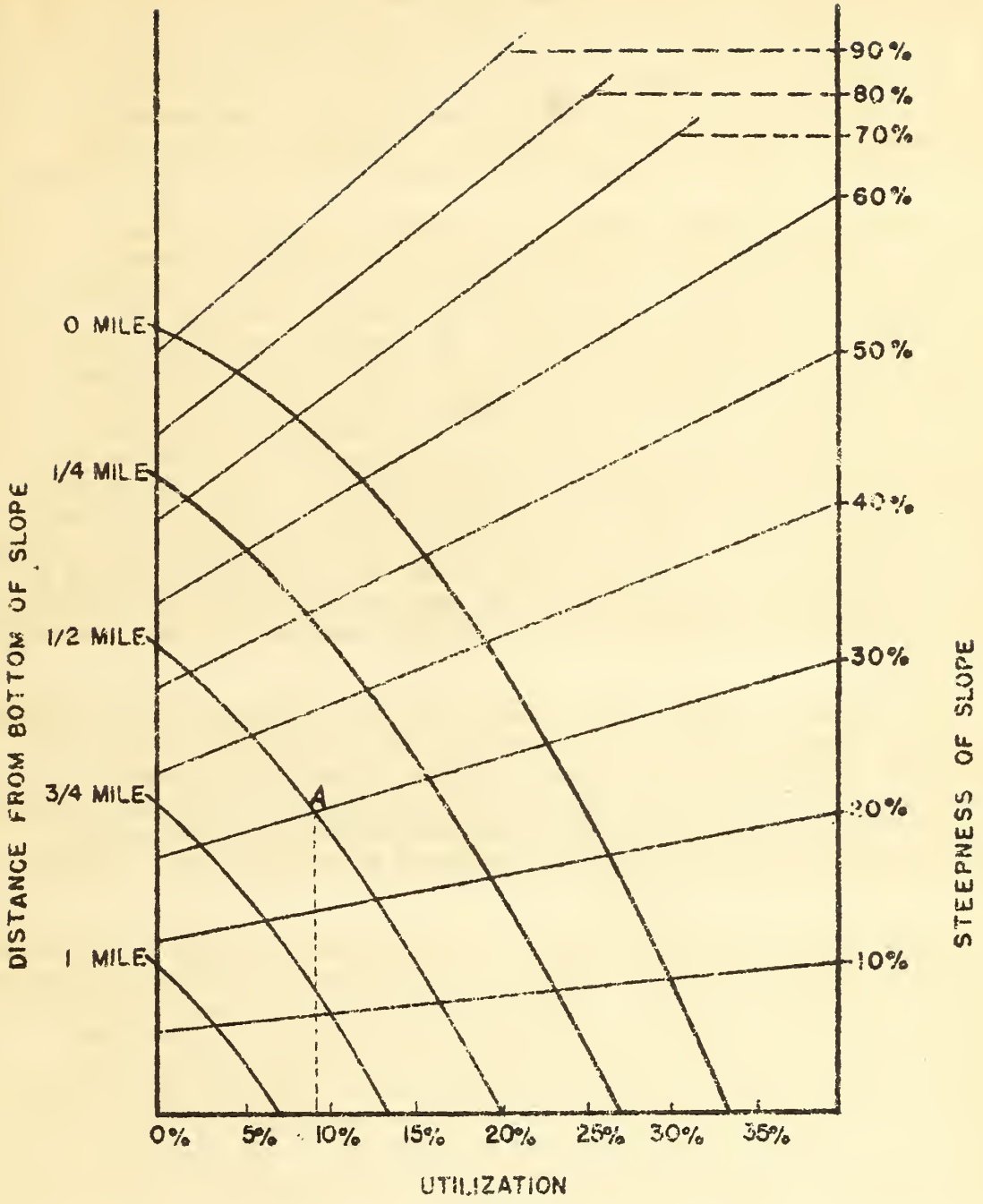


Figure 3.—Effect of steepness and distance from bottom of slope on percent grazing use of mountain muhly. (Example: To find the percent utilization at a point 1/2 mile from the bottom of a 30-percent slope, follow the line marked "1/2 mile" to point "A" where it crosses the line marked "30%." A vertical line drawn from "A" to the base of the chart shows the utilization to be about 9 percent.)

On allotment A, average steepness of slope was 10 percent, and the average distance from the bottom of all slopes was .15 mile, indicating that although slopes on this allotment were more pronounced than on the other two allotments, they were as a whole neither very steep nor very long. The trends in figure 3 show that for mountain muhly grazing use ceases at a distance of 1 mile from the bottom of all slopes exceeding 20 percent, while on a 40-percent slope, use declines from about 19 percent along the lower edge to 5 percent at 1/2 mile from the bottom of the slope and ceases at slightly less than 3/4 mile from the bottom.

Based on the average slope for the entire allotment, actual grazing use declined about 6.5 percent for each 1/4 mile of travel up the slope, and on the basis of the average distance from the bottom of all slopes, it declined approximately 3.5 percent for each 10-percent increase in steepness of slope. An exception was found along the ridge tops where heavy use is invariably encountered. Cattle use the tops of all but the highest and roughest ridges as resting places and to escape flies, and once on top of a long slope may graze part way down the adjacent slope rather than all the way up from the bottom. With overstocking, some grazing use is obtained even on very steep and remote areas. But since slope exerts such a strong inhibiting influence on cattle movement, it is unsafe in computing grazing capacity to consider forage located more than 1/2 mile from the bottom of slopes exceeding 40 percent. To attempt full grazing use of such areas will result in severe overuse and ultimate destruction of the forage cover on the more accessible level areas.

The factor of slope exposure was found to be insignificant in affecting degree of grazing use. It is probable that on some range areas this factor may be an indirect influence on degree of use. For example, south slopes, covered principally with grama grasses, may be grazed heavier than north slopes with pine-bunchgrasses predominating. However, such variations in grazing use should be attributed to differences in vegetation and not directly to exposure.

Trails and other access routes. Within timbered areas where natural barriers are numerous, the major part of the movement of cattle takes place along well-established trails. To a lesser extent this same condition is true on broad areas of level or rolling open grassland. In the pine-bunchgrass type, all roads, unless subjected to frequent use by motor vehicles, serve as cattle trails since they are well brushed out and free of obstacles which make for insecure footing or impediment to travel. An example of the effect of distance from a cattle trail upon the grazing use of Arizona fescue and mountain muhly as measured on allotment C is shown in figure 4. Similar data were obtained on allotments A and B.

From the trends shown in figure 4, it may be seen that the actual decrease in grazing use due to each 1/8 mile increase in distance from a trail amounted to slightly over 7 percent in the case of both grasses. In areas of heavy timber reproduction, rough terrain, or with numerous surface obstacles, such as boulders, logs, and down timber, grazing use was observed to cease at a much shorter distance than indicated. On the open grassy parks, where there were few surface obstacles and the cattle could move freely in any direction, this factor was of less importance. On allotment B the measured average grazing use on areas where rocks

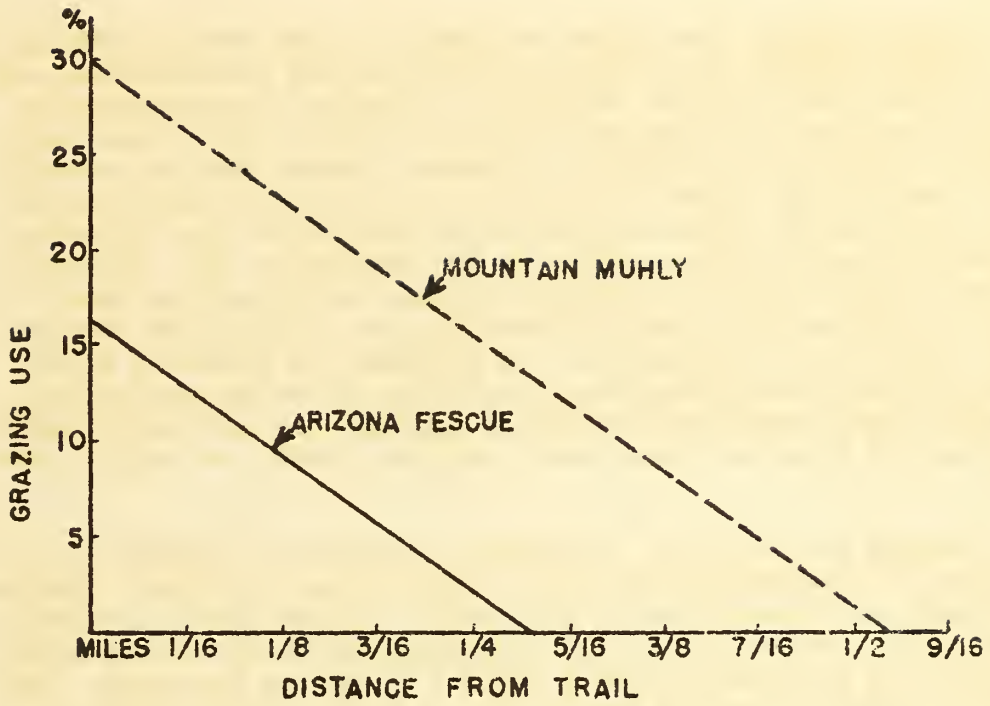


Figure 4.— Effect of distance from a trail upon grazing use of mountain muhly and Arizona fescue.

covered 40 percent or more of the ground surface was 3 percent for Arizona fescue and 12 percent for mountain muhly as compared to measured use of 12 percent and 26 percent, respectively, for the same grasses on comparable areas with no surface rock present.

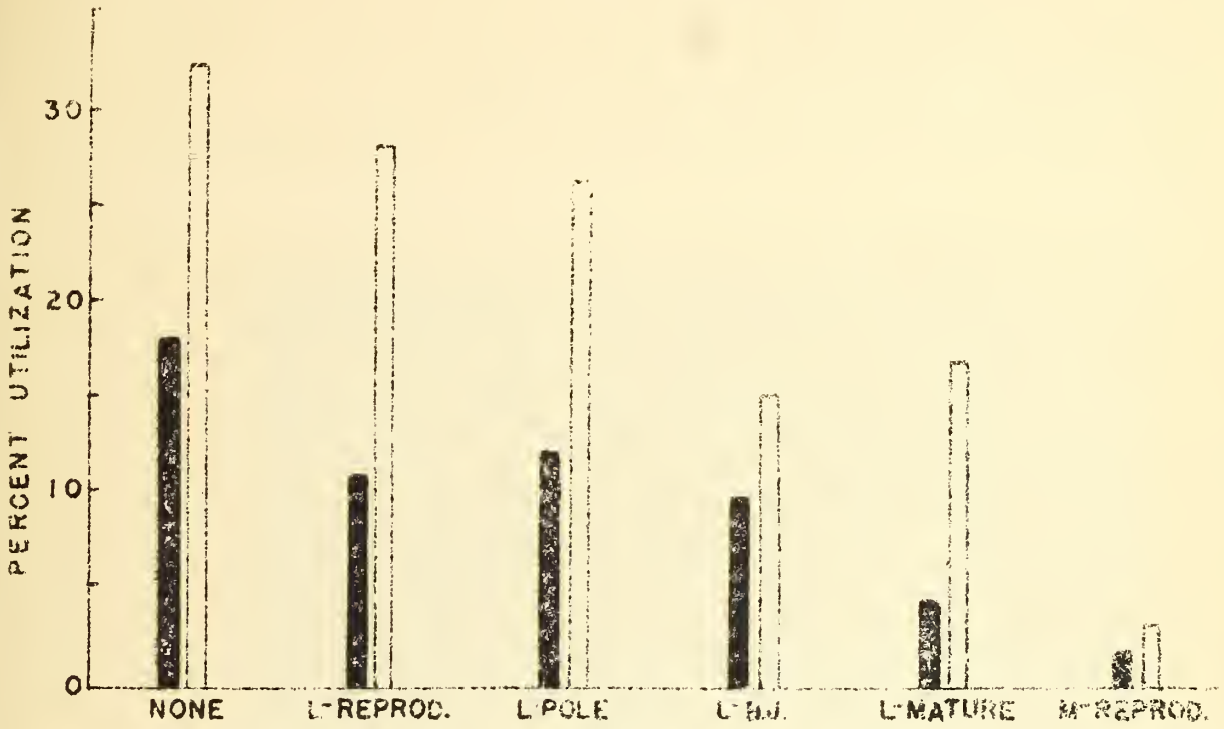
The influence of timber debris is shown by the fact that on allotment C average use of mountain muhly on clear areas was 27 percent as compared to 19 percent on areas with 10 to 20 percent of the ground surface occupied by slash, logs, and fallen limbs. In extreme cases cattle may be completely excluded from small areas of forage by these natural barriers.

Timber stands. The effect of stands of pine timber upon cattle movement and grazing use of forage plants has long been observed, and where timber occurs in dense stands some allowance is made for this factor. Quantitative measurements of the effect of this factor are difficult to obtain and interpret, however, because both the density of the stand and age class or size of the trees in the stand are involved. In general, degree of grazing use decreases directly with increased size of the trees making up the stand (fig. 5). The data shown are from allotment C where pine timber in general was about typical of that on the pine-bunchgrass type as a whole, but is much lighter than that on allotment B. As indicated in figure 5, light stands of pine reproduction have only slight effect on grazing use, but medium stands practically prohibit grazing use, and heavy stands (more than 880 trees per acre) are a complete barrier to cattle movement.

Part of the cause for the light use under the large trees is related to the accumulation of needle litter under the trees. Whether the presence of a deep layer of pine needle litter, which is closely associated with shade, results in an undesirable change in chemical composition of the forage grasses growing therein is not known. But, there is a definite lack of grazing use on forage plants growing in needle litter. It is possible that the effect of shade results in grass herbage relatively low in protein and vitamin A. The influence of shade is readily recognized by the more slender stems and relatively pale color. Figure 6 shows a typical condition on allotment C where the accumulation of needle litter on the ground results in very light use of the forage grasses despite proximity to a main water trail. Figure 7 shows graphically for the same area the measured variation in grazing use.

Factors Which Affect Forage Value

Season of use. Average grazing use on the three allotments studied was 10.4 percent for Arizona fescue and 23.8 percent for mountain muhly. The use of fescue on a season-long basis is secondary to that of the muhly. However, during the early summer when muhly is dormant and some green forage is available on fescue this grass is grazed relatively heavier than on an all-season basis. Data collected at the end of July on allotment B, where use was 6.49 and 7.77 percent, respectively, on the fescue and muhly, indicate a ratio of approximately 1:1. Under present accepted utilization standards, proper use for these species is 25 percent for Arizona fescue and 30 percent for mountain muhly on a volume removal basis. Hence grazing use on three allotments studied was moderate.



LEGEND

NONE---------- NO TREES PRESENT

L-REPROD.------LIGHT REPRODUCTION--(1-20 ON 50' CIRCLE)

M-REPROD.------MEDIUM " --(21-40 ON 50' CIRCLE)

L-POLE--------LIGHT POLE---------(1-5 ON 50' CIRCLE)

L-B.J.---------LIGHT BLACK JACK----(1-2 ON 50' CIRCLE)

L-MATURE------LIGHT MATURE------(1-2 ON 50' CIRCLE)

■----------ARIZONA FESCUE

□----------MOUNTAIN MUHLY

Figure 5.— Effect of size and number of trees upon grazing use of bunchgrasses.

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Figure 6.- Grazing use is invariably light wherever the soil surface is covered with needle litter.

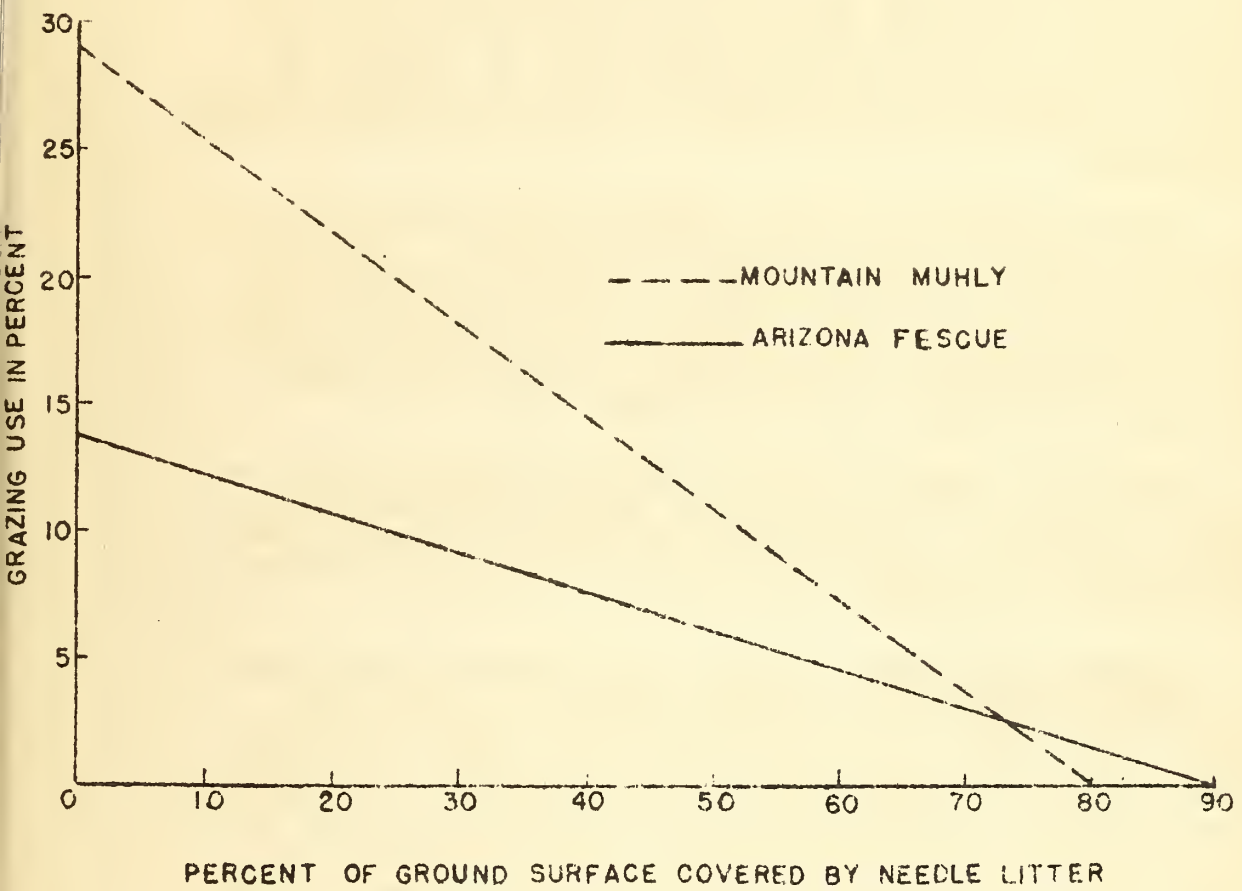

Figure 7.—Effect of needle litter upon grazing use of bunchgrasses.

Range condition. On the three allotments 29 sites were recognized as excellent, 484 as good, 334 as fair, and 46 as poor. As indicated in figure 8, there are two possible explanations for the apparent relationship between range condition and degree of use: (1) Prolonged heavy grazing of a given area leads to poor condition of the soil, change in floristic composition of the plant cover, decreased density and low vigor of the forage plants, all of which would be recognized as a poor or possibly fair site. Viewed in this manner, range condition may logically be considered a direct result of grazing use. (2) Cattle tend to return to and graze areas that have been closely grazed the previous year (fig. 9). This may be because the herbage is more succulent on account of less fiber (fewer old stems and leaves) and also possibly to the greater nutritive value of new growth.

In many instances poor range condition may be primarily attributed to disturbance, usually man-caused, such as fires, logging, or plowing in unsuccessful crop production. Observation revealed that areas which had previously been subjected to such disturbances generally were closely grazed. It is probable that improvement in plant cover from the standpoint of grazing value as well as for erosion control will be extremely slow on such areas.

Burning or logging or baring the land by cultivation also accentuates the effect of various climatic factors. Wind movement, humidity, temperature, and evaporation are extreme on denuded areas and conditions for the natural development of a new plant cover are ordinarily very unfavorable.

Floristic composition. Grazing use of Arizona fescue appears to be largely dependent on the relative abundance of other more palatable range forage. The relationship between degree of use of Arizona fescue and the occurrence (expressed as percent composition of total forage) of mountain muhly is shown graphically in figure 10. The trend indicates that the grazing value of Arizona fescue as expressed in degree of use decreases with an increased abundance of mountain muhly. For example, grazing use of Arizona fescue is about 16 percent on sites where no mountain muhly is present; but when the latter makes up 87 percent of the range forage, the degree of use on the fescue drops to about 8 percent.

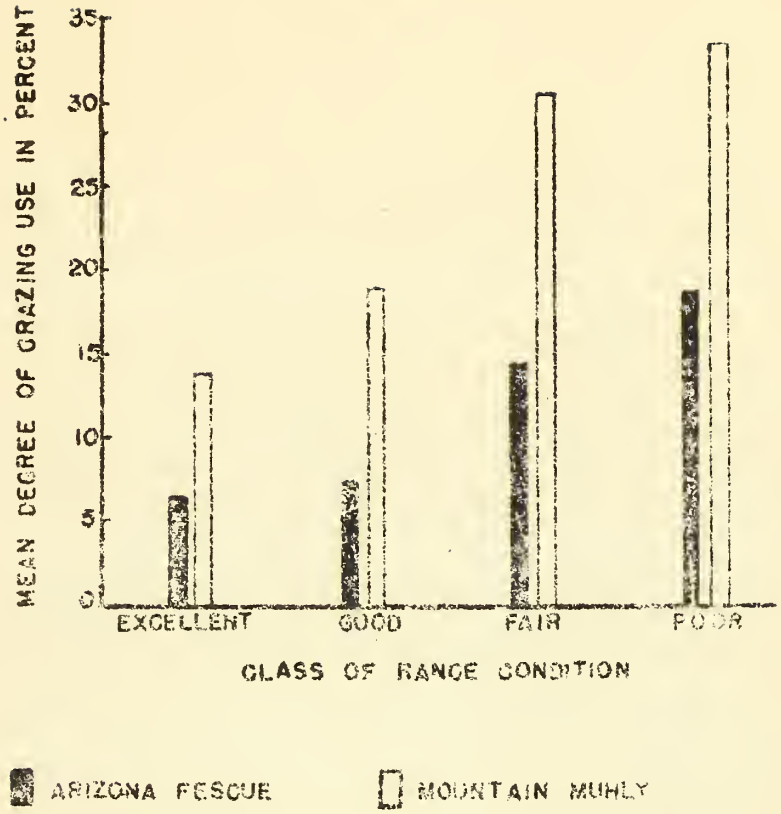

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Figure 8.- Relation of degree of use to range condition.

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Figure 9.- Old cut-over ponderosa pine area. Continual heavy grazing, possibly due to attraction of livestock to weeds, prevents range recovery.

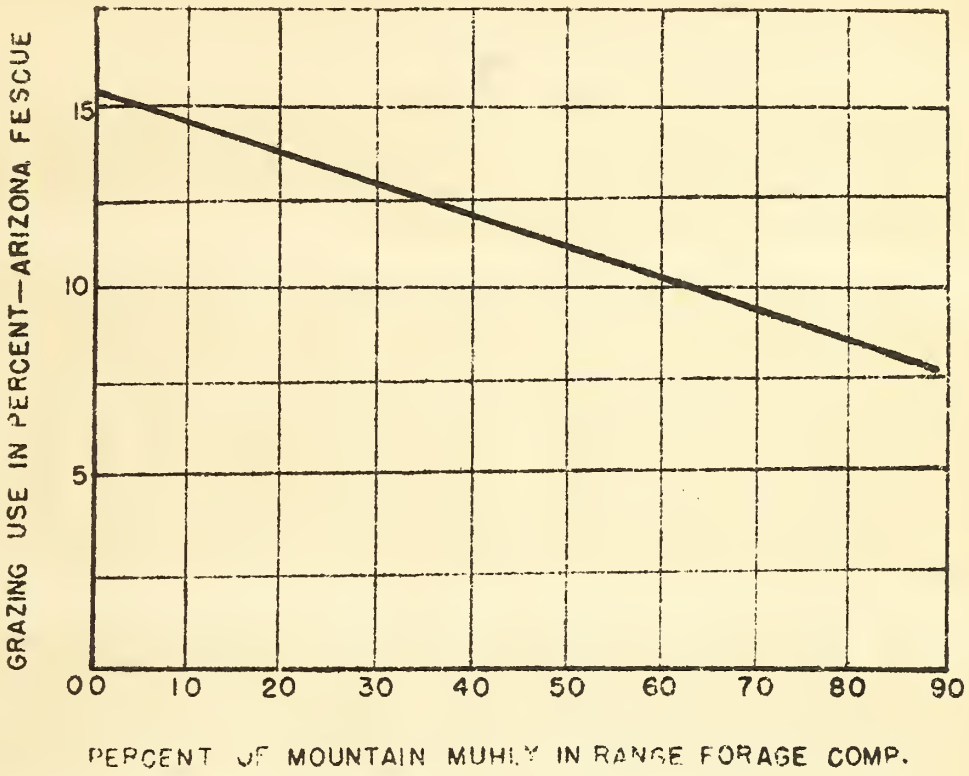

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Figure 10.-- Relation of degree of use of Arizona fescue to percentage of mountain muhly in range forage composition.

SUMMARY

Pine-bunchgrass range in northern Arizona is naturally grazed un-uniformly by cattle. Major factors influencing the manner in which pine-bunchgrass ranges are grazed when reasonably stocked with cattle include:

1. Distance from water. The general use of large areas of forage located more than 1 to 2 miles from water is impractical. Development of water offers one of the best means of preventing range deterioration in localized areas through more effective distribution of grazing use over the entire range unit.

2. Steepness and length of slope bear an important influence on degree of grazing use. For example, a narrow fringe along the bottom of a slope as steep as 80 percent may be readily grazed, whereas grazing use will generally be negligible on slopes of 20 percent prolonged for a distance of a mile. Both steepness and length of slope should be given careful consideration in the delineation of key areas for range inspection purposes and in estimating grazing capacity. Range areas greater than 1/2 mile from slope bottom where gradient is steeper than 40 percent should be excluded from grazing capacity estimates.

3. Trails and other access routes. Within timbered areas where natural barriers are present the major portion of cattle movement and subsequent grazing use will concentrate in narrow belts bordering the main trails. To a lesser extent this is true also in the open, rolling grasslands. Trail development offers a means of improving distribution of grazing use.

4. Density of timber stand. Degree of grazing use generally decreases directly with increased size of the trees making up the stand. Light stands of pine reproduction have only a slight effect on grazing use but medium stands inhibit forage utilization and heavy stands are a complete barrier to cattle movement. Use of timbered areas should be encouraged during early summer and again in the fall to make use of weeds. Cattle should be moved immediately following the first killing frost.

5. Season of use. The use of Arizona fescue on a season-long basis is secondary to mountain muhly. However, in the early summer when muhly is dormant and fescue is green, the latter grass is grazed heavier than on an all-season basis. Average grazing use on the three allotments studied was 10.4 percent for Arizona fescue and 23.8 percent for mountain muhly. This degree of utilization was moderate as judged from accepted standards of use for these two species.

6. Range condition. Poor range condition results from such disturbing influences as past heavy grazing use, fire, logging, and baring of land by plowing. Unfortunately these areas are generally closely grazed year after year so that improvement in plant cover is prevented.

7. Floristic composition. Grazing use of Arizona fescue decreases with increased abundance of mountain muhly.

LIST OF COMMON AND BOTANICAL NAMES

Grasses

Alpine timothy	Phleum alpinum
Arizona fescue	Festuca arizonica
Arizona threeawn	Aristida arizonica
Black dropseed	Sporobolus interruptus
Bottlebrush squirreltail	Sitanion hystrix
Blue grama	Bouteloua gracilis
Bullgrass	Muhlenbergia emersleyi
Kentucky bluegrass	Poa pratensis
Little bluestem	Andropogon scoparius
Mountain muhly	Muhlenbergia montana
Mutton bluegrass	Poa fendleriana
Pine dropseed	Blepharoneuron tricholepis
Prairie junegrass	Koeleria cristata
Red threeawn	Aristida longiseta
Redtop	Agrostis alba
Spike muhly	Muhlenbergia wrighti
Water foxtail	Alopecurus geniculatus

Weeds

Aster	Aster spp.
Clover	Trifolium spp.
Daisy	Erigeron spp.
Lupine	Lupinus spp.
Pingue	Actinea Richardsoni
Rabbitbrush	Chrysothamnus spp.
Rose pussytoes	Antennaria rosea
Snakeweed	Gutierrezia spp.
Vetch	Vicia spp.

Trees and Shrubs

Fendler ceanothus	Ceanothus fendleri
Gambel oak	Quercus gambeli
Mountain-mahogany	Cercocarpus spp.
New Mexican locust	Robinia neomexicana
Ponderosa pine	Pinus ponderosa